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Short Communication

Bark-stripping of tankan orange, *Citrus tankan*, by the roof rat, *Rattus rattus*, on Amami Oshima Island, southern Japan

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In 1997, roof rats, *Rattus rattus,* damaged the bark of cultivated tankan orange, *Citrus tankan* Hayata, trees over a wide area of the central part of Amami Oshima, an island in the Nansei Shoto archipelago of southern Japan. This was the first time that tankan farmers had experienced such damage in more than 30 years of cultivation of the fruit. At first, it was believed that the introduced mongoose, *Herpestes* sp., had damaged the trees, but later, from the appearance of the tooth marks on the trees, it was surmised that the rats were responsible. The damage which occurred from early April until early October 1997 was found in an area where other potential mammalian culprits such as *R. norvegicus, Tokudaia osimensis* and *Diplothrix legata* were known to be absent.

Bark-stripping by *R. rattus* has been reported elsewhere (*e. g.*, Maeda 1982, 1985, Santini 1987), but has not previously involved the tankan orange, making the damage caused on Amami Oshima Island notable. In this paper the bark-stripping activity of the roof rat is described, and the data on their movements around a tankan orchard, their food habits and their age composition are examined.

Study Area and Mothods

Amami Oshima Island is a 712 km² island situated at 28°10-30' N, 129°10-45' E (Fig. 1). It is situated in the sub-tropical zone, and has a warm, humid climate with mean monthly temperatures ranging from a low of 14.2°C in January to a high of 28.4°C in July and an annual mean temperature of 21.3°C. Rainfall amounts to 2,871 mm a year.

In mid-September 1997, I carried out a study in a tankan orchard where severe damage occurred (Fig. 1). The orchard situated in the Naze City administrative district had a total area of about 1.2 ha, which was divided into several plots by woods composed of evergreens such as *Castanopsis cuspidata, Symplocos* spp., *Melia azedarach* and *Pinus luchuensis*.

Rats were studied by trapping and tracking. They were captured in 29 live traps set for one night at 3-5 m intervals along the edge of a wood that faced an orchard plot of about 400 m². They were tracked using fluorescent

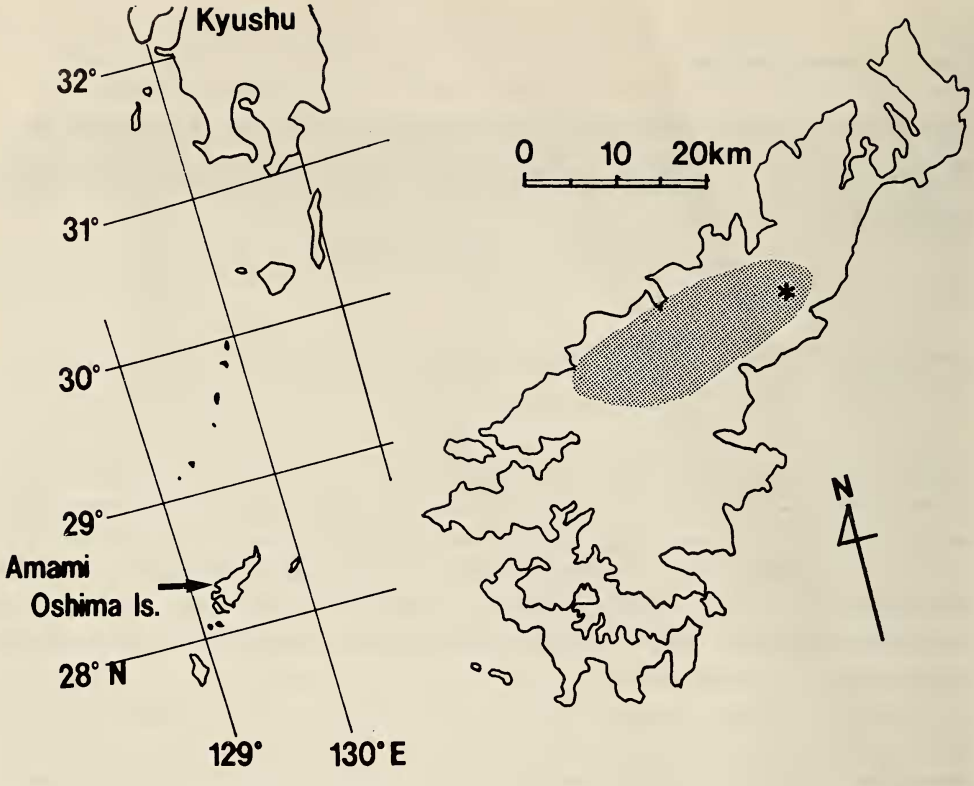

Fig. 1. Amami Oshima Island, showing the study site (asterisk) and the approximate area including Naze City, Yamato Village and Sumiyo Village, where bark-stripping by rats occurred (shaded).

pigments following the method described by Lemen and Freeman (1985). Trapped rats were put into bags containing fluorescent pigments, gently shaken and released in the morning. During the following night, from circa 23 : 00 onwards, their trails were detected with a 4W UV-lantern.

Ninety snap traps were also set for one night at 3–5 m intervals along the same woodland/orchard boundary near where the live traps had been set. Snap traps were baited with sweet potatoes covered with peanut butter and honey. Specimens were dissected in the laboratory, and their stomachs were removed for closer examination under a stereoscopic microscope following the method by Yabe (1979). The volume that different food items contributed to each stomach's contents (excluding bait) was estimated, and the mean volume of each food item was calculated for all stomachs examined. Rats were aged on the basis of their eye-lens weights using Tanikawa's formula (Tanikawa 1993), and individuals three months of age or older were defined as adults.

Results and Discussion

Bark-stripping by rats has previously been reported from both Europe and

Southeast Asia. In Central Italy, the roof rat was considered to be responsible for heavy bark-stripping activity on *Pittosporum tobira* shrubs in urban parks (Santini 1987), although the reason for the activity remained uncertain. Maeda (1982, 1985) reported bark-stripping of ipil-ipil, *Leucaena leucocephala,* trees by *R. rattus mindanensis*, although in my opinion the species was identified erroneously given that the specimens collected had white tipped tails and weighed 250 -400 g, characteristics typical of *R. everetti*, not *R. rattus*.

In Amami Oshima Island, I confirmed that the species de-barking tankan trees was the roof rat by finding their tooth marks on trees, their hairs in feces found below trees as well as by direct trapping. The rats stripped bark mainly from near the bases of the trunks of young trees less than five years old and from the branches of older trees. Most of the damaged trees were completely girdled (Fig. 2A). The damage extended to all parts of the orchard surveyed, even to trees at the center, some 20 m from the nearest forest edge.

Tracking of two rats dusted with fluorescent pigments revealed that they had moved about 15-20 m through the woods along the edge of the tankan orchard before turning into the orchard and attacking the tankan trees about 5-8 m inside. The tankan orchard apparently provided the rats with little shelters because there were no ground cover, whereas the surrounding woods probably provided shelter, preferred runways, as well as foods such as acorns.

A total of 21 rats (18 females and 3 males) were collected over 90 trap-nights around the tankan orchard. Seventeen of the 18 females were adult, but

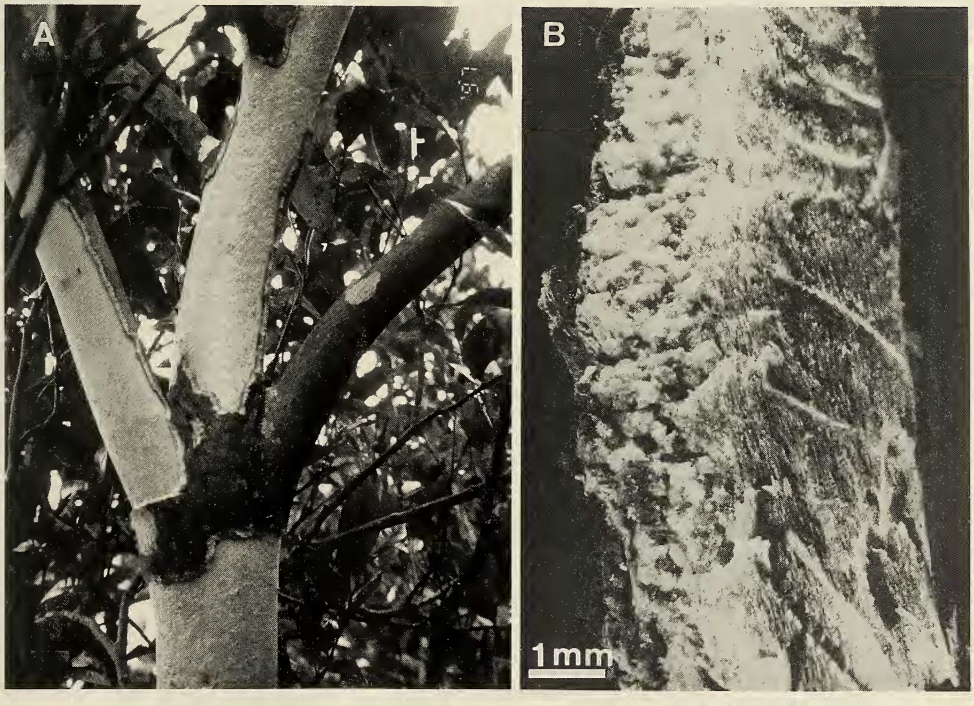

Fig. 2. Bark-stripping of tankan orange, *Citrus tankan*, trees (A), and tooth marks on the inside of fallen bark chips (B).

Table 1. Age composition of roof rats trapped around a tankan orchard.

Age in month	No. of individuals		
	Males	Females	Total
2	0	1	1
3	0	0	0
4	0	2	2
5	0	1	1
6	1	0	1
7	0	4	4
8	1	3	4
9	0	3	3
10	0	0	0
11	0	1	1
>12	1	3	4
Total	3	18	21

none were pregnant. The majority of individuals (52%, 11 of 21) were 7-9 months old (see Table 1) indicating that a major breeding season had lasted from December 1996 to February 1997. S. Hattori (pers. comm.) was of the opinion that the roof rat population had exploded during the previous winter owing to a heavy crop of acorns.

Tankan phloem, which was identified by the characteristic sieve areas of the tissue, was found in two (11%) out of 18 stomachs examined, however, no trace of outer bark was found in those stomachs. Tooth marks left on the inside of the bark chips clearly indicated that rats chewed the phloem contained in the bark chips as well as on the tree surface (Fig. 2B). The fact that rat feces were filled with phloem fibers indicated that they digested phloem incompletely, and presumably absorbed only the sap. Seeds and fruits accounted for 30.1% of the stomach contents in volume, and phloem accounted for 8.9% (Fig. 3).

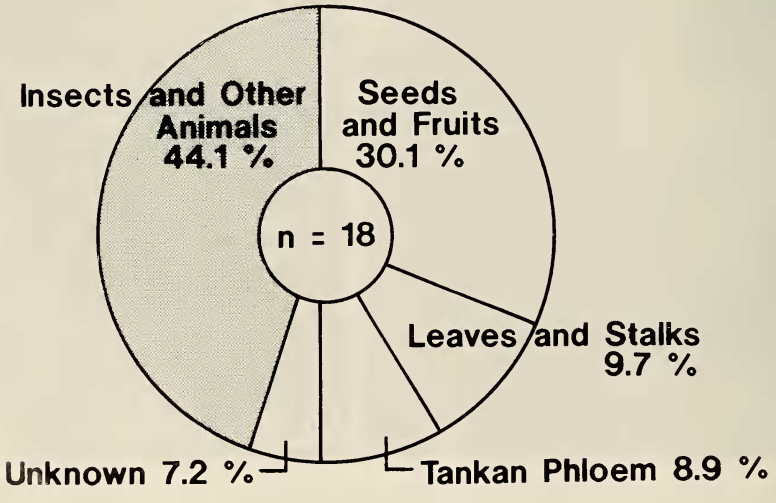

Fig. 3. The stomach contents of roof rats in Amami Oshima Island.

The preferred diet of the roof rat has been shown to consist of seeds and fruits in general (Yabe 1979), although it will switch to more succulent foods such as herb stems in order to obtain moisture (Yabe 1982). Stomach analysis of specimens trapped during this study confirmed that seeds and fruits were primary food source of the roof rats, and showed that phloem was at most a supplementary, not a substitute food source. I conclude that roof rats stripped the bark of the tankan orange trees to obtain the sap in the phloem. The reason for this activity remains uncertain, though they may have involved accessing extra moisture and/or extra nutrients.

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References

Lemen, C. A. and P. W. Freeman. 1985. Tracking mammals with fluorescent pigments : a new technique. J. Mammal. 66 : 134−136.

Maeda, M. 1982. Tree damage by the roof rat (*Rattus rattus mindanensis*) in the northern area of Mindanao. Monthly Bull. Overseas Agric. Dev. News 82 : 15−27 (in Japanese).

Maeda, M. 1985. Rat control in an ipil-ipil plantation in Mindanao, the Philippines. Monthly Bull. Overseas Agric. Dev. News 107 : 12−17 (in Japanese).

Santini, L. A. 1987. Rodent debarking activity in urban and natural parks of central Italy : progress towards integrated control strategies. *In* (Richards , C. G. J and T. Y. Ku, eds.) Control of Mammal Pests. pp. 55−64. Taylor & Francis, London.

Tanikawa, T. 1993. An eye lens weight curve for determining age in black rats, *Rattus rattus*. J. Mammal. Soc. Japan 18 : 49−51.

Yabe, T. 1979. The relation of food habits to the ecological distributions of the Norway rat (*Rattus norvegicus*) and the roof rat (*R. rattus*). Jpn. J. Ecol. 29 : 235−244.

Yabe, T. 1982. Habitats and habits of the roof rat *Rattus rattus* on Torishima, the Izu Islands. J. Mammal. Soc. Japan 9 : 20−24.

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